



# Technical Support Document: Toxicology Clandestine Drug Labs: Methamphetamine

Volume 1, Number 7

## SODIUM HYDROXIDE

**Authors:** Charles Salocks, PhD, DABT and Karlyn Black Kaley, PhD, DABT

**Reviewers:** Page Painter, MD, PhD and David Siegel, PhD, DABT

**Editor:** Karlyn Black Kaley, PhD, DABT

**Staff Support:** Caron Poole and Cristen Dahl

### Introduction

The clandestine synthesis of methamphetamine (meth) and other illegal drugs is a growing public health and environmental concern. For every pound of meth synthesized there are six or more pounds of hazardous materials or chemicals produced. These are often left on the premises, dumped down local septic systems, or illegally dumped in backyards, open spaces, in ditches along roadways or down municipal sewer systems. In addition to concerns for peace officer safety and health, there is increasing concern about potential health impacts on the public and on unknowing inhabitants, including children and the elderly, who subsequently occupy dwellings where illegal drug labs have been located.

The Office of Environmental Health Hazard Assessment (OEHHA), in cooperation with the Department of Toxic Substances Control (DTSC), has been charged with assisting in identifying and characterizing chemicals used or produced in the illegal manufacturing of methamphetamine, which pose the greatest potential human health concerns. To address in part this growing environmental problem and the need for public health and safety professionals to make appropriate risk management decisions for the remediation of former methamphetamine laboratory sites, OEHHA has developed two types of chemical-specific information documents.

The first set, technical support documents (TSDs), are referenced, multi-page publications, which contain important health and safety data, exposure limits, and key information for recognizing chemicals used or produced during the manufacturing of methamphetamine. These documents will likely be most helpful to health and safety officers, industrial hygienists, or others interested in more detailed toxicological information. The second set, two-page fact sheets, contain much of the same information as the corresponding TSDs; however, the details are presented in a more succinct, graphical format. The fact sheets will be helpful to individuals, including the public, who want to be able to quickly recognize potential chemicals of concern found in illegal methamphetamine labs in order to avoid inadvertent exposures and resulting health impacts.

For more information or to obtain copies of these and other documents, contact:

DEPARTMENT OF TOXIC  
SUBSTANCES CONTROL

P.O. Box 806  
Sacramento, CA 95812-0806

[www.dtsc.ca.gov/SiteCleanup/](http://www.dtsc.ca.gov/SiteCleanup/)

OFFICE OF ENVIRONMENTAL  
HEALTH HAZARD ASSESSMENT

P.O. Box 4010  
Sacramento, CA 95812-4010

[www.oehha.ca.gov](http://www.oehha.ca.gov)

## **I. Chemical Name**

### **A. SODIUM HYDROXIDE (NaOH)**

### **B. Synonyms**

Caustic soda, soda lye. Sodium hydroxide is one of several alkaline materials referred to as "lye" (ATSDR, 2000).

## **II. Role in Clandestine Drug Synthesis: Methamphetamine**

Sodium hydroxide is used to make sodium, an alkali metal that functions as a catalyst in the anhydrous ammonia/alkali metal method (Nazi method) that reduces ephedrine and/or pseudoephedrine to methamphetamine (Turkington, 2000). Sodium hydroxide is also used in the hydriodic acid/red phosphorus method to raise the pH of methamphetamine solutions that have an acid pH.

## **III. Chemical Description**

### **A. Appearance**

Solid white granules, chips, or pellets. Solid forms rapidly absorb water vapor from the air, generating heat. Concentrated solutions of sodium hydroxide in water are available from chemical supply companies.

### **B. Taste**

No information found.

### **C. Odor**

None. Sodium hydroxide is not volatile and is odorless at room temperature.

### **D. Odor Threshold**

Not applicable. Sodium hydroxide is odorless.

### **E. Irritancy Threshold**

Mild to moderate respiratory irritation is experienced at a concentration of 0.5 mg/m<sup>3</sup> (AIHA, 2002; OEHHA, 1999). If inhaled, mist or dust containing sodium hydroxide will cause irritation and burning of the nasal passages and airways. Therefore, irritation of the nose and throat provides an indication that the concentration of airborne sodium hydroxide is sufficient to produce initial symptoms of toxicity.

### **F. Odor Safety Class**

Not applicable. Sodium hydroxide is odorless. Therefore, odor provides no warning of hazard. Mild irritation of the nose and throat provides an indication of exposure to a mist or dust containing sodium hydroxide at a concentration greater than 0.5 mg/m<sup>3</sup>, a concentration that is sufficient to produce initial symptoms of toxicity.

### **G. Vapor Density**

Not applicable.

## **H. Vapor Pressure**

1 mmHg at 739° C (1362° F); therefore, sodium hydroxide is not significantly volatile at room temperature.

## **IV. Containers and Packaging**

### **A. Commercial Products**

Concentrated solutions are available from commercial suppliers. Commercial products in solid form include Red Devil® Lye and Drano® drain opener, while liquids include Easy Off® oven cleaner and Liquid-Plumner® drain opener.

### **B. Pharmaceutical Use**

No pharmaceutical uses for sodium hydroxide were identified (USP, 1998).

## **V. Chemical Hazards**

### **A. Reactivity**

Mixed with water, solid forms and concentrated solutions (>40%) of sodium hydroxide may generate enough heat to ignite combustible materials (ATSDR, 2000). Sodium hydroxide reacts with all mineral and organic acids, forming the corresponding salts. The heat generated may be sufficient to raise the temperature above the boiling point, resulting in sporadic, dangerous "bumping" of the solution (HSDB, 2001). Sodium hydroxide also reacts with metals, such as aluminum, tin, and zinc, generating flammable hydrogen gas (Genium, 1999).

### **B. Flammability**

Sodium hydroxide is noncombustible. However, if solid sodium hydroxide is mixed with water or acid it may generate enough heat to ignite combustible materials (HSDB, 2001).

### **C. Chemical Incompatibilities**

Sodium hydroxide is incompatible with acids, halogenated organic compounds, metals, and nitromethane. Mixing sodium hydroxide with acid may generate substantial heat. Reaction with trichloroethylene (TCE) spontaneously forms dichloroacetylene, which is flammable. Reaction with metals, such as aluminum, tin, and zinc, generates flammable hydrogen gas (Genium, 1999). Sodium hydroxide is corrosive to most metals.

## **VI. Health Hazards**

### **A. General**

Sodium hydroxide is strongly corrosive and a powerful irritant by all routes of exposure (inhalation, ingestion, skin contact, and eye contact). It can cause severe burns and permanent damage to any tissue it contacts. The mechanism of burning is two-fold; thermal burns result from sodium hydroxide combining with moisture and consequent production of heat, and chemical burns result from reaction with organic molecules. Aerosols and airborne particles are very irritating to the upper respiratory tract and may cause pulmonary edema (accumulation of fluid in the lungs). Sodium hydroxide reacts quickly on contact with tissue and does not produce systemic toxicity (i.e., it does not produce effects distant from the point of contact).

## **B. Acute Effects**

Acute effects, resulting from short-term exposure to high concentrations of sodium hydroxide, include irritation and burning of the skin, eyes, nose, windpipe, and lungs. One-time, high-level inhalation of sodium hydroxide may lead to swelling of the larynx and irreversible obstructive lung disease (ATSDR, 2000; OEHHA, 1999). Early symptoms of ingestion include abdominal pain and vomiting. Perforation of the gastrointestinal tract and shock are also possible, and may not become apparent until several hours after ingestion. Contact with 25-50% solutions produces immediate skin irritation, while dilute solutions (4% or less) may not cause irritation for several hours. Eye contact initially causes burning and may lead to permanent eye damage. It may not be possible to determine the full severity of eye damage for up to seventy-two hours following exposure (ATSDR, 2000).

## **C. Chronic Effects**

Chronic effects resulting from long-term exposure to low concentrations of airborne sodium hydroxide include nose and throat irritation, chest pains, shortness of breath, and ulceration of the nasal passages. Chronic skin exposure may cause dermatitis (ATSDR, 2000).

## **D. Skin Contact**

Skin contact with sodium hydroxide granules or concentrated solutions causes chemical and thermal burns leading to deep tissue injury. Following contact with 25-50% solutions, irritation becomes apparent within about three minutes. Burns appear soft and moist and are very painful. Less severe exposures cause inflammation, redness, and swelling. Contact with dilute solutions of sodium hydroxide may not produce pain for several hours, but serious burns can result if the chemical is not washed off promptly. Short-term exposure to small amounts, followed by rapid recovery, is not likely to cause delayed or long-term effects. Chronic skin exposure may cause dermatitis (ATSDR, 2000).

## **E. Eye Contact**

Eye contact with sodium hydroxide granules or concentrated solutions can hydrolyze proteins in the eyes, causing severe burns and eye damage. Formation of surface lesions, destruction of cells, inflammation, and opacification of the cornea may follow. Ulcerations may progress for several days following exposure (ATSDR, 2000). Potential outcomes include cataracts, glaucoma, adhesion of the eyelid to the cornea, blindness, and eye loss.

## **F. Inhalation**

Inhalation of sodium hydroxide particles or mist may cause irritation of the mouth, nose, throat, and upper respiratory tract. Tolerance to these effects may occur if exposure is recurrent or prolonged. High concentrations are very irritating to the upper respiratory tract and may result in pulmonary edema. Potential conditions resulting from long-term exposure include persistent hoarseness and reactive airway dysfunction syndrome (RADS), a chemical or irritant-induced type of asthma (ATSDR, 2000).

## **G. Ingestion**

Ingestion of sodium hydroxide causes severe and rapid corrosive injury to the mouth, esophagus, and stomach. [Note: The absence of visible burns in the mouth does not reliably exclude the presence of esophageal burns (HSDB, 2001).] Swallowing immediately becomes painful and difficult; drooling may be profuse. Chest and abdominal pain are often present. Vomiting, prostration, rapid and feeble pulse, and collapse may occur. In persons who recover, constrictive

scarring of the esophagus and gastrointestinal tract ultimately may result (ATSDR, 2000). Cases of squamous cell carcinoma of the esophagus have occurred with a latent period of 12-42 years after ingestion, but these cancers are not thought to be due to a direct carcinogenic action of sodium hydroxide (HSDB, 2001).

## **H. Predisposing Conditions**

Persons with pre-existing skin, eye, or respiratory disease (e.g., asthma or emphysema) may be more sensitive to sodium hydroxide. Persons with glaucoma should not be exposed to mists or aerosols of sodium hydroxide since it can raise eye pressure. Concurrent exposure to other irritants or caustic materials may enhance the toxic effects of sodium hydroxide. Elevated ambient temperatures may enhance the toxicity of sodium hydroxide (OEHHA, 1999).

## **I. Special Concerns for Children**

Compared with adults, the ratios of lung surface area to body weight and respiratory minute volume to body weight are greater in children. Therefore, at any given concentration of sodium hydroxide in air, children will probably receive a larger dose than adults will. Children also may be more sensitive to inhaled sodium hydroxide because of the smaller diameter of their airways. If the inhaled dose is sufficient to cause swelling or spasms of the larynx, upper airway obstruction and asphyxia are more likely to occur in children. Children may be more susceptible to the toxic effects of airborne sodium hydroxide because they are often less likely to leave an area where a release has occurred. Children also appear to be more susceptible to ingested sodium hydroxide because their gastric acid is not sufficiently strong or present in sufficient quantity to neutralize even small quantities of strongly alkaline chemicals. Sodium hydroxide accounts for 75% of all caustic injury to the esophagus in children less than five years of age; 83% of these cases are under three years of age, and 62% are male (Gossel & Bricker, 1994).

## **VII. First Aid**

### **A. Eyes**

Flush eyes immediately with water for at least fifteen minutes, occasionally lifting eyelids. Get medical attention immediately (Mallinckrodt, 2001).

### **B. Skin**

Rapid decontamination is critical (ATSDR, 2000). Remove contaminated clothing and shoes. Immediately wash skin with plenty of water for at least fifteen minutes. Get medical attention immediately. Wash clothes before reuse (Mallinckrodt, 2001).

### **C. Ingestion**

Do not induce vomiting. Give 4-8 ounces of water or milk. Do not administer activated charcoal or attempt to neutralize stomach contents (ATSDR, 2000). Never give anything by mouth to an unconscious person. Get medical attention immediately (Mallinckrodt, 2001).

### **D. Inhalation**

Remove victim to fresh air. If victim is not breathing, give artificial respiration. If victim has trouble breathing, give oxygen. Get medical attention immediately (Mallinckrodt, 2001).

## VIII. Standards for Inhalation Exposure

### A. Occupational Exposure Limits (NIOSH, 1997; ACGIH, 1994)

- |                                                        |                      |
|--------------------------------------------------------|----------------------|
| 1. Ceiling Limit (C) (not to be exceeded at any time): | 2 mg/m <sup>3</sup>  |
| 2. Short-Term Exposure Limit (STEL or ST):             | Not established.     |
| 3. 8-Hour Time Weighted Average (TWA):                 | 2 mg/m <sup>3</sup>  |
| 4. 10-Hour Time Weighted Average (TWA):                | Not established.     |
| 5. Immediately Dangerous to Life & Health (IDLH):      | 10 mg/m <sup>3</sup> |

Important Definitions Follow:

Ceiling Limit (C) is a concentration that must not be exceeded during any part of the workday.

Short-Term Exposure Limit (STEL or ST) is a 15-minute time-weighted average concentration that should not be exceeded during any part of the workday.

8-Hour Time Weighted Average (8-hour TWA) concentration is an exposure standard that must not be exceeded during any 8-hour work shift of a 40-hour workweek. 8-Hour TWA exposure standards established by the Occupational Safety and Health Administration (OSHA) are called Permissible Exposure Limits (PELs). 8-Hour TWA exposure standards established by the American Conference of Governmental Industrial Hygienists (ACGIH) are called Threshold Limit Values (TLVs).

10-Hour Time Weighted Average (10-hour TWA) concentration is an exposure standard that must not be exceeded during a 10-hour workday of a 40-hour workweek. 10-Hour TWA exposure standards developed by the National Institute for Occupational Safety and Health (NIOSH) are called Recommended Exposure Limits (RELs).

Immediately Dangerous to Life & Health (IDLH) defines a concentration which poses a threat of death or immediate or delayed permanent health effects, or is likely to prevent escape from such an environment in the event of failure of respiratory protection equipment. IDLH values are developed by the National Institute for Occupational Safety and Health (NIOSH).

"Skin" notation (NIOSH): significant uptake may occur as a result of skin contact. Therefore, appropriate personal protective clothing should be worn to prevent dermal exposure.

### B. Emergency Response Planning Guidelines (1 hour or less) (AIHA, 2002)

- |                                                          |                       |
|----------------------------------------------------------|-----------------------|
| 1. ERPG-1 (protective against mild, transient effects):  | 0.5 mg/m <sup>3</sup> |
| 2. ERPG-2 (protective against serious adverse effects):  | 5 mg/m <sup>3</sup>   |
| 3. ERPG-3 (protective against life-threatening effects): | 50 mg/m <sup>3</sup>  |

NOTE: There is a significant discrepancy between the IDLH concentration (10 mg/m<sup>3</sup>) and the ERPG-3 concentration (50 mg/m<sup>3</sup>). Both values are intended to provide an estimate of a life-threatening concentration. Given the lack of human toxicity data for lethality of inhaled sodium

hydroxide, OEHHA recommends using the IDLH value as an estimate of a potential lethal concentration.

Emergency Response Planning Guidelines (ERPGs) are developed by the American Industrial Hygiene Association (AIHA) to assist in planning and preparation for catastrophic accidental chemical releases. ERPGs allow emergency response planners to estimate the consequences of large-scale chemical releases on human health, and evaluate the effectiveness of prevention strategies and response capabilities. ERPGs assume that the duration of exposure is one hour or less. They are not intended to be used as limits for routine operations and are not legally enforceable.

Definitions for the three ERPG levels are:

ERPG-1: an estimate of the maximum airborne concentration below which nearly all individuals could be exposed for up to one hour without experiencing more than mild, transient adverse health effects or without perceiving a clearly defined objectionable odor.

ERPG-2: an estimate of the maximum airborne concentration below which nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair an individual's ability to take protective action.

ERPG-3: an estimate of the maximum airborne concentration below which nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects.

### **C. Acute Reference Exposure Level (1-hour exposure) (OEHHA, 1999)**

Level protective against mild adverse effects: 0.008 mg/m<sup>3</sup>

### **D. Chronic Reference Exposure Level (multiple years) (OEHHA, 2002)**

Level protective of adverse health effects: Not established.

Reference Exposure Levels (RELs) are developed by the California EPA's Office of Environmental Health Hazard Assessment (OEHHA). A REL is a concentration at or below which no adverse health effects are anticipated, even in the most sensitive members of the general population (for example, persons with pre-existing respiratory disease). RELs incorporate uncertainty factors to account for information gaps and uncertainties in the toxicological data. Therefore, exceeding a REL does not necessarily indicate an adverse health impact will occur in an exposed population. Acute RELs are based on an assumption that the duration of exposure is one hour or less. Chronic RELs are intended to be protective for individuals exposed continuously over at least a significant fraction of a lifetime (defined as 12 years).

### **E. Chronic Reference Concentration (lifetime exposure)(IRIS, 2003)**

Level protective of adverse health effects: Not established.

## **IX. Environmental Contamination Concerns**

### **A. Surface Water**

Sodium hydroxide is designated as a hazardous substance under Section 311(b)(2)(A) of the Federal Water Pollution Control Act and further regulated by the Clean Water Act Amendments of

1977 and 1978. These regulations apply to discharges of sodium hydroxide (HSDB, 2001). As a contaminant in surface water, the primary effect of sodium hydroxide would be to raise the pH.

## **B. Groundwater**

Sodium hydroxide is highly reactive and is rapidly neutralized by organic chemicals in soil. For this reason, it is not expected to migrate downward through soil to groundwater.

## **C. Drinking Water**

Suggested No Adverse Response Level (NAS, 1980): Not established.

Preliminary Remediation Goal for Tap Water (U.S. EPA, 2002 Region IX): Not established.

## **D. Soil**

Sodium hydroxide would be expected to react with water and organic materials in soil, thereby becoming neutralized.

Preliminary Remediation Goal for Residential Soil (U.S. EPA, 2002 Region IX): Not established.

## **E. Air**

Sodium hydroxide is subject to wet deposition (washout by rainfall) and dry deposition. It will readily combine with water vapor in air, and the resulting aerosol or mist will be corrosive.

Preliminary Remediation Goal for Ambient Air (U.S. EPA, 2002 Region IX): Not established.

## **F. Indoor Surface Contamination**

Skin contact and ingestion resulting from hand-to-mouth activity would be expected if accessible surfaces were contaminated with solid or liquid forms of sodium hydroxide. Clean-up standards for sodium hydroxide on surfaces have not been established.

## **X. Personal Protective Equipment**

Wear a full face-piece, positive pressure, air-supplied respirator and chemical safety goggles or a full-face shield if splashing is possible. Wear impervious and protective clothing, boots, gloves, and coveralls (Mallinckrodt, 2001).

## **XI. References**

ACGIH, 1994: American Conference of Governmental Industrial Hygienists (1994). *1994-1995 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices*. American Conference of Governmental Industrial Hygienists; Cincinnati, OH.

AIHA, 2002: American Industrial Hygiene Association (2002). *The AIHA 2002 Emergency Response Planning Guidelines and Workplace Environmental Exposure Level Guides Handbook*. American Industrial Hygiene Association; Fairfax, VA.

ATSDR, 2000: Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Services (2000). *Managing Hazardous Materials Incidents, Volume III. Medical Management Guidelines for Acute Chemical Exposure. Sodium Hydroxide (NaOH)*. Retrieved from: <http://www.atsdr.cdc.gov/MHMI/mmg178.html>



Genium, 1999: Genium Publishing Corporation (1999). *Sodium Hydroxide*. Genium's Handbook of Safety, Health, and Environmental Data for Common Hazardous Substances. McGraw-Hill Companies, Inc.; Schenectady, NY.

Gossel & Bricker, 1994: Gossel, T.A., Bricker, J.D. (1994). *Principles of Clinical Toxicology*. Second Edition. Raven Press, Ltd.; New York, NY.

HSDB, 2001: Hazardous Substances Data Bank, National Library of Medicine (2001). TOXNET (Toxicology Data Network). *Sodium Hydroxide*. Retrieved from: <http://toxnet.nlm.nih.gov/>

IRIS, 2003: Integrated Risk Information System, National Library of Medicine (2003). TOXNET (Toxicology Data Network). Retrieved from: <http://toxnet.nlm.nih.gov/>

Mallinckrodt, 2001: Mallinckrodt Baker, Inc. (2001). *Material Safety Data Sheet for Sodium Hydroxide*. Phillipsburg, NJ.

NAS, 1980: National Academy of Sciences (1980). *Volume 3: Drinking Water and Health*. National Research Council, Safe Drinking Water Committee. National Academy Press; Washington, D.C.

NIOSH, 1997: National Institute for Occupational Safety and Health, U.S. Department of Health and Human Services (1997). *NIOSH Pocket Guide to Chemical Hazards*. DHHS (NIOSH) Publication No. 97-140. NIOSH Publications; Cincinnati, OH.

OEHHA, 1999: Office of Environmental Health Hazard Assessment, California Environmental Protection Agency (1999). *Determination of Acute Reference Exposure Levels for Airborne Toxicants. Acute Toxicity Summary: Sodium Hydroxide*.

OEHHA, 2002: Office of Environmental Health Hazard Assessment, California Environmental Protection Agency (2002). *All Chronic Reference Exposure Levels Adopted by OEHHA as of September 2002*. Retrieved from: [http://www.oehha.ca.gov/air/chronic\\_rels/pdf/allchrels.pdf](http://www.oehha.ca.gov/air/chronic_rels/pdf/allchrels.pdf)

Turkington, 2000: Turkington, R. (2000). *HazCat® Methamphetamine Chemical/Waste Identification System*. Haztech Systems, Inc.; San Francisco, CA.

U.S. EPA, 2002: United States Environmental Protection Agency, Region IX (2002). *Preliminary Remediation Goals, Sodium Hydroxide*. Retrieved from: <http://www.epa.gov/Region9/waste/sfund/prg/files/02table.pdf>

USP, 1998: United States Pharmacopeial Convention, Inc. (1998). *Drug Information for the Health Care Professional*. Volume 1. Eighteenth Edition. United States Pharmacopeial Convention, Inc.; Rockville, MD.